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WATER QUALITY MANAGEMENT PLAN

FOR THE

LITTLE MISSOURI DRAINAGE, MONTANA

Prepared for
Environmental Protection Agency
Region VIII
Denver, Colorado

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WATER QUALITY MANAGEMENT PLAN FOR THE

LITTLE MISSOURI DRAINAGE, MONTANA

INTRODUCTION

This report presents information relative to water quality and water quality management in the Little Missouri River basin (Figure I). This is one of sixteen basins designated by the State of Montana for preparation of water quality management plans. The Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500) have directed states to prepare such plans as part of a nation-wide program for controlling water pollution. This Act states that not later than July 1, 1977, effluent limitations for point sources, other than publicly owned treatment works, shall require the application of best practicable control technology available. For publicly owned treatment works in existence on July 1, 1977, effluent limitations will be based on secondary treatment.

The objectives of this effort are to provide the State with water quality data and related information to (1) determine the water quality characteristics of all natural and waste waters, (2) determine what factors, both natural and man-made, effect the quality of waters, (3) develop a management strategy for maintaining and enhancing the quality of waters in the Little Missouri River basin and, (4) provide information needed to determine whether Montana's water quality standards are and will continue to be met. Also included is a description of physical characteristics of the basin. The general methodology used in this study was the compilation and evaluation of existing water quality data and related information. Where information was deficient, field investigations and water and wastewater sampling and analysis were completed to obtain the needed information.

This investigation does not present a detailed analysis of the area's resources, but summarizes water quality related information. As additional

information becomes available, the Little Missouri River basin Water Quality Management Plan will be revised and updated as part of Montana's Continuing Planning Process.

Assistance in obtaining information for this report was obtained from a number of agencies and persons. The Montana Department of Natural Resources provided information on land use, water use, economy and population. Thanks are also given to residents in the basin that kindly supplied information on the area's resources.

RELATED INVESTIGATIONS AND PLANS

There have been a number of reports and investigations of water quality and water quality related resources in the basin. Coal deposits in the Little Missouri and adjacent basins have spurred an increasing activity and interest in water resources. Also, there is continued interest in development of water systems for agricultural purposes. A number of federal, state and private organizations are actively working on programs in southeastern Montana.

The Missouri River Basin Comprehensive Framework Study (1969) broadly describes water quality and related resources of the entire Upper Missouri River basin including the Little Missouri River basin. The North Central Power Study (Anon., 1971) was a broad planning effort directed at coal. It discussed energy distribution, coal resources and pollution in southeastern Montana. The U. S. Bureau of Reclamation (1972) prepared a report describing water storage and conveyance plans that could be used to furnish water to coal developments in Montana and Wyoming. The U. S. Forest Service (1972) is preparing a plan for multiple use of the Custer National Forest that involves both land and water use. The Northern Great Plains Resource Program is beginning a study of southeastern Montana to assess the impact of massive coal development on the area's water resources.

Water resources and water quality in the upstream portion of the Little Missouri River basin has been described by the Wyoming State Engineer's Office (1972). The State of South Dakota (1972) wrote an interim water quality management program for the Little Missouri River basin in South Dakota. The Water Resources Division of the Montana Department of Natural Resources is developing a framework plan for Montana. The Little Missouri River drainage will be included as part of this plan.

There have been no areawide waste treatment management plans in the basin under Section 208 of the Federal Water Pollution Control Amendments of 1972, and no such plans are anticipated in the next five years. Similarly, there have been no wastewater facility plans under Section 201 of the Act and no such plans are anticipated in the next five years.

BASIN PHYSICAL CHARACTERISTICS

The Little Missouri River basin (Figure 1 and Plate I) includes approximately 75 percent of Carter County, 33 percent of Fallon County, and 38 percent of Wibaux County and has a total area of about 3,360 square miles. The Little Missouri River basin is an area of rolling hills with gentle to moderate relief. There are six sub-basins in the area; however, there are only four perennial streams in the drainage - Beaver Creek, Little Beaver Creek, Box Elder Creek and the Little Missouri River. All streams except in the extreme southeast tip of the area are tributary to the Little Missouri River which in turn flows into the reservoir formed by Garrison Dam in North Dakota. An area of about 11 square miles in the extreme southeast corner of the Little Missouri Basin drains into the Belle Fouche River in Wyoming and South Dakota.

There are two waste discharges, six water quality monitoring stations, two streamflow gauging stations and eight weather stations in the basin. (Plate I).

All surface waters within the Little Missouri River basin have been classified by the State of Montana as B-D_3. A B-D_3 designates that the quality is to be maintained suitable for drinking, culinary and food processing purposes after adequate treatment equal to coagulation, sedimentation, filtration, disinfection and any additional treatment necessary to remove naturally present impurities; bathing, swimming and recreation; growth and propagation of nonsalmonid fishes and associated aquatic life, waterfowl and furbearers; agricultural and industrial water supply. The detailed criteria for B-D_3 waters are given in Montana's Water Quality Standards (Appendix I).

The entire Little Missouri River basin is designated as one segment by the State of Montana and has been classified as an effluent limitation class segment. This classification indicates that water quality in the segment is meeting and will continue to meet applicable standards or where water quality will meet applicable water quality standards after application of effluent limitations required by the Federal Water Pollution Control Act Amendments of 1972. This investigation has indicated that all waters in the Little Missouri River basin presently meet and will continue to meet all applicable water quality standards; therefore, the segment is classified as an effluent limitation segment.

CLIMATE

The Little Missouri River basin has a semi-arid climate characterized by cold dry winters, cool moist springs and warm summers. The average annual precipitation for the area ranges from 11 to 14 inches. Approximately 75 percent of the precipitation falls during the April through September period which permits extensive dryland farming. There are eight weather stations operating in the basin. (Table I). All these stations are maintained by private individuals and are NOAA (National Oceanographic and Atmospheric Administration) cooperative

Figure 1—Sketch map showing Little Missouri River Basin

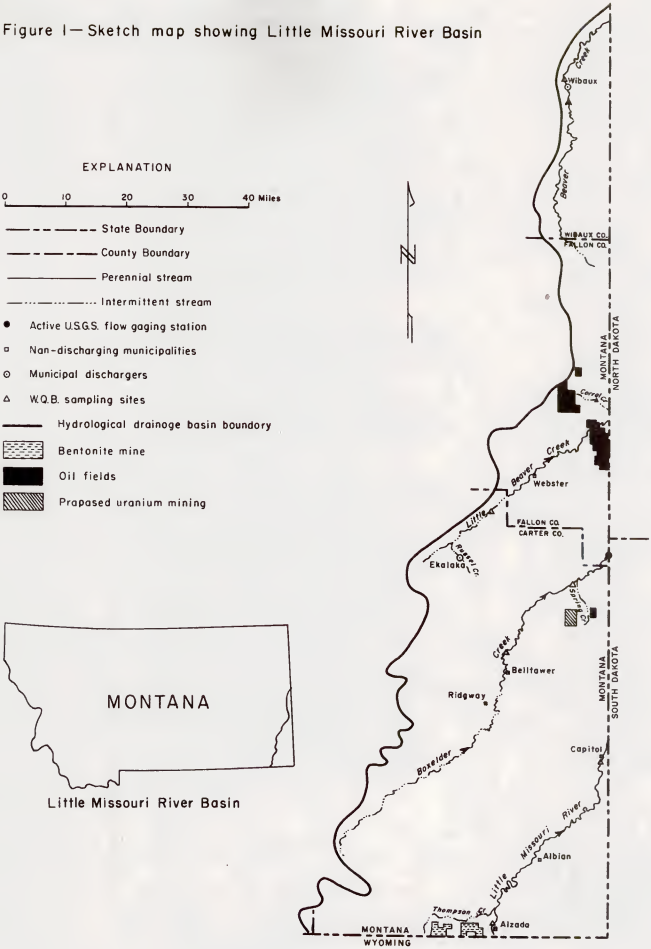


FIGURE 2
AVERAGE PRECIPITATION
FOR LITTLE MISSOURI RIVER BASIN
(Based on data obtained from U. S. Weather Bureau for Ekalaka
for the thirty years between 1941-1970)

MONTH	30-Yr. Ave. Mo. PRECIPITATION (Inches)
J	0.41
F	0.36
M	0.57
A	1.28
M	2.01
J	3.52
J	2.03
A	1.54
S	1.37
O	0.69
N	0.50
D	0.32

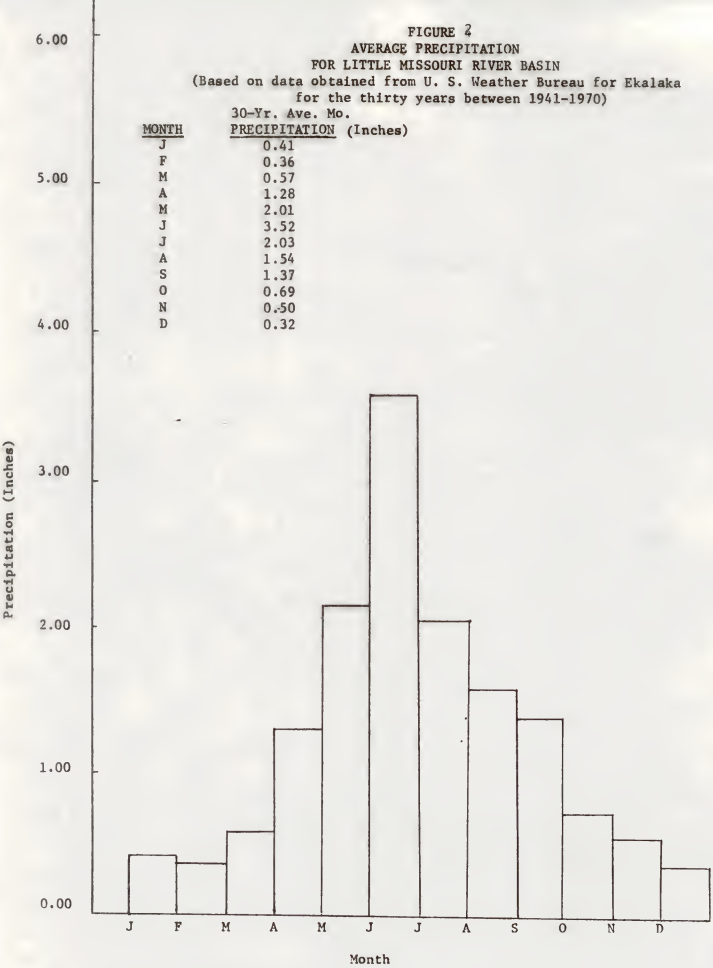
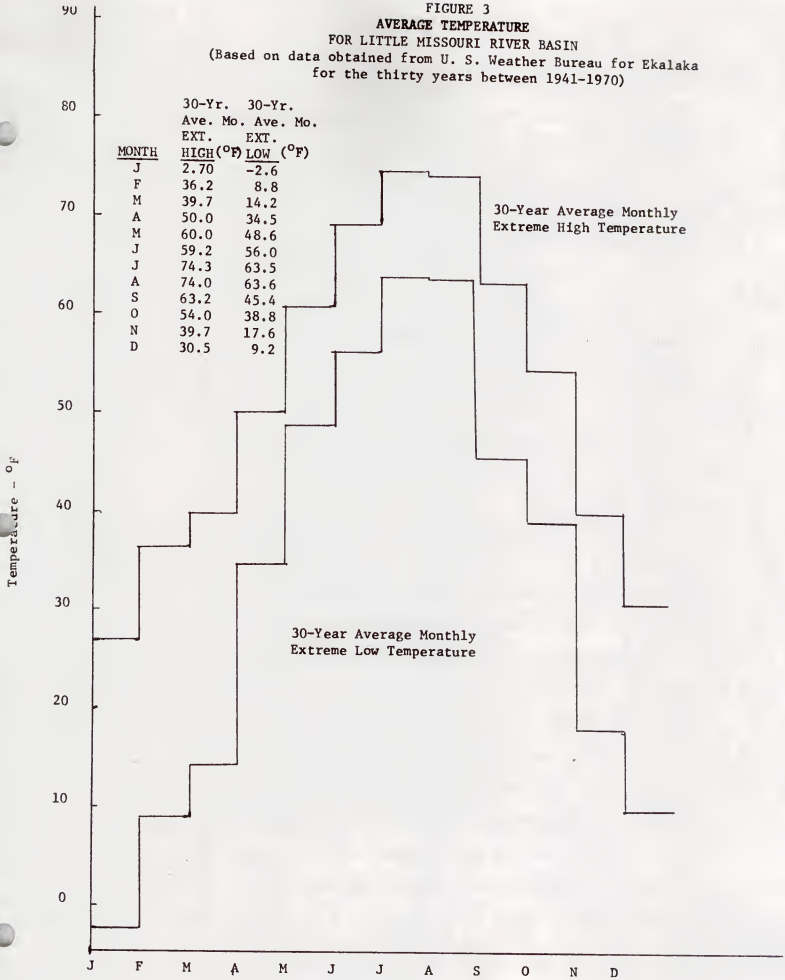


FIGURE 3

AVERAGE TEMPERATURE

FOR LITTLE MISSOURI RIVER BASIN

(Based on data obtained from U. S. Weather Bureau for Ekalaka for the thirty years between 1941-1970)



stations. Average monthly and extreme high and low temperatures for the basin from 1941 to 1970 are shown in Figure 2 and average monthly precipitation from 1941 to 1970 is shown in Figure 3.

TABLE 1. Weather Stations in the Little Missouri River Basin

Station Name	Location	Temp.	Precipitation	Gauging	No. of Years of Record
Wibaux	14N60E08	X	X	Non-recording	22 years
Webster	03N60E02		X	" "	22 years
Knobs	02N61E24		X	" "	22 years
Belltower	02S59E24		X	" "	22 years
Albion	07S61E29	X	X	" "	22 years
Alzada	09S60E19		X	Recording	Unknown
Carlyle	12N59E27	X	X	Non-recording	Unknown
Ridgway	04S59E10	X	X	" "	21 years
Ekalaka	02N58E32	X	X	Recording	22 years

Note: X in column indicates these data are being collected.

Hydrogeology:

The primary source of water for stock and domestic purposes in the Little Missouri River Basin is water wells and in much of the area wells are the only source of water. There are an estimated 1,000-1,250 wells in the area and water from an estimated 300-400 springs has been appropriated for use. The towns of Ekalaka and Wibaux obtain water from wells. Technical reports that discuss geological and groundwater resources of the basin include Taylor (1964), Peterson (1962), Erdmann and Larsen (1954), Howard (1960), May (1954) and Perry (1931, 1935).

Geological history of the area includes long periods of sedimentation interrupted only by minor uplift and erosion, until the close of the Cretaceous age (65 to 135 million years ago). Major structural upheaval occurred at the end of Cretaceous age and at the beginning of the Tertiary age (65 million years ago). After this period of structural upheaval, a long period of erosion and sedimentation resumed and has continued to the present time.

Geological formations of importance in the area include alluvium of Recent geological age (less than 20,000 years old); the Arikaree, White River and Fort Union Formations of Tertiary age (1 to 65 million years old); the Hell Creek, Fox Hills, Pierre Shale and other shale formations of the Colorado group all of Cretaceous age (65 to 135 million years old).

Recent Alluvium is present along major streams in the area. The alluvium is relatively thin and consists of unconsolidated mixtures of clay, silt, sand and gravel. The alluvium yields small quantities of fair to poor quality water to wells.

The Arikaree and White River Formations cap the Ekalaka Hills, the Long Pine Hills, Sheep Mountains and other areas of high relief in Carter County. These formations consist of light-colored sandstones and shales and some gray limestone. These sediments are poorly cemented, but contain some resistant cliff-forming layers. These formations are dissected and generally do not contain significant quantities of groundwater. Some wells yield small quantities of fair to good quality water from sandstone layers in these formations.

The Fort Union Formation is exposed at the ground surface in much of central and northern parts of the area. The Fort Union Formation consists of over 1,000 feet of alternating beds of sandstone and shale with occasional seams of coal. It is composed of the Tongue River Member (upper unit) and the Lebo Shale Member (lower unit). The Tongue River Member consists of light-colored sandstone and shale and lignite coal beds. Groundwater can usually be obtained from the deeper sandstone and coal beds in adequate quantity and quality for stock and domestic purposes. The Lebo Shale Member consists primarily of shale and is a poor aquifer.

The Hell Creek Formation underlies the Fort Union Formation. The Hell Creek is several hundred feet thick and is exposed in a band across central Carter County and southeast of Baker. The Hell Creek consists of shale and sandstone

with a relatively thick basal sandstone that yields small quantities of fair quality water to numerous wells.

Underlying the Hell Creek Formation is the Fox Hills Formation consisting of 100 to 200 feet of sandstone, siltstone and shale. The upper part of the Fox Hills Formation yields small quantities of poor quality water to numerous wells in the area. Beneath the Fox Hills Formation is about 3,500 to 4,500 feet of dark marine shales including the Pierre Shale and the Colorado Group. These shales are exposed over wide areas in the southern half of Carter County and in the central part of Fallon County. These shales are essentially non-waterbearing and are not used as a source of groundwater.

Beneath these marine shales is the Dakota Formation of Cretaceous age which outcrops south of Alzada, Montana. The Dakota Formation consists of about 250 feet of sandstone that yields water to numerous wells in South Dakota and North Dakota. In Montana, the Dakota dips downward and is generally too deeply buried to be of importance. Beneath the Dakota are many thousands of feet of sedimentary rocks that are too deeply buried to be of significance.

Soils

Soils groups most widely represented in the Little Missouri River basin in Montana are those developed along drainage ways, on flood plains, low terraces, fans and foot slopes; and those developed on uplands.

The soils on flood plains and low terraces are nearly level and gently sloping with slopes ranging from 0 to 4 percent. These soils have slow runoff and a slight erosion hazard. The soils on fans and foot slopes are generally moderately to strongly sloping with slopes ranging from 5 to 15 percent. These soils have medium to rapid runoff and have a moderate to severe erosion hazard.

Soils developed on flood plains, low terraces, fans and foot slopes are mainly deep, well drained and have a loamy or clayey texture. However, some of

these soils, particularly on flood plains, are somewhat poorly to poorly drained and have a high salt content throughout their profiles.

Soils developed on uplands are mostly well drained, have a clayey or silty texture and can be classed into two main groups. Group one consists of mainly moderately sloping to steep soils with slopes ranging from 4 to 45 percent. These soils are mostly moderately deep and shallow to sandstone or shale bedrock. They have medium to rapid runoff and the erosion hazard is moderate to severe. The other group of upland soils consists of gently sloping to moderately sloping soils with slopes ranging from 2 to 8 percent. These soils are mostly deep and moderately deep with sandstone and shale bedrock. They have slow to medium runoff and the erosion hazard is slight to moderate. Within the area of upland soils are badlands and very steeply sloping, shallow soils. In such areas, runoff is very rapid and the erosion hazard is very severe. These areas have a high potential as sediment and salt sources to streams. Also in the upland area are some sandy soils developed in residium from sandstone. These soils are mostly moderately deep to bedrock and runoff is mainly slow and the erosion hazard slight.

Soils in the Little Missouri River basin are used for dryland and irrigated crops and for range. Soils on flood plains, low terraces, fans and foot slopes are used mainly for dryland crops with some areas under irrigation. Soils on uplands are used mainly for range with some gently to moderately sloping soils used for dryland crops.

Land Use

The main land use in the Little Missouri River basin is for livestock grazing. Of the basins 2,147,200 acres of land, approximately 80 percent is classified as grazing land including 90,000 acres of National Forest Land. Approximately 182,000 acres of land in the basin are cultivated with 42,000 acres being considered irrigated. Dryland crops include spring and winter wheat, barley,

alfalfa, corn and hay. Irrigated lands produce mostly hay and small amounts of corn silage. Other land uses include roads, railroads, oil and gas production, bentonite mining and urban development. Although the northern half of the basin has extensive reserves of lignite in the Fort Union Formation, no commercial coal development is presently underway.

Water Use:

The predominant water use in the Little Missouri basin is for irrigation used to provide forage for the livestock industry. Much of this irrigation has been developed privately by individuals and small groups through construction of diversions, small dams and reservoirs, and extensive water spreading systems. In the same manner, they have developed a large number of stock watering facilities, which is another significant water use. The most substantial industrial use of water is in water flooding for secondary recovery of oil. Injection water for secondary recovery originates from process water separated from oil or from water wells. Municipal and rural domestic water use is reflective of the low population density and is largely unquantified except for the communities of Alzada, Ekalaka and Wibaux.

Alzada has no central water system, but relies entirely on individual wells. The estimated yearly water use in Alzada is about 1.9 million gallons per year. Both Ekalaka and Wibaux have community systems using groundwater sources. Ekalaka uses about 29.3 million gallons per year and Wibaux requires about 22.0 million gallons per year.

Two potential water development projects exist in the basin, Mill Iron Dam in Carter County and the Beaver Creek watershed in Wibaux County. Both of these could provide future water supplies for municipal, industrial, fish and wildlife, recreation, and irrigation purposes. However, both are rather small

and large-scale development, such as coal, would require importation of water into the basin.

Population and Economy:

Major communities in the Little Missouri River basin are listed below, along with their 1970 population.

Alzada	50
Ekalaka	663
Hammond	13
Wibaux	644

Population and employment data are not available on a drainage basin basis. The data (Table 2) for Carter and Wibaux counties, which include Ekalaka and Wibaux, have been summed and analyzed to describe the basin. Fallon County has not been included in the analysis. About 33 percent of Fallon County is in the basin, but the major population center, the community of Baker, is not in the basin.

Historically, both population and employment have experienced a steady decline (Table 2). This trend is projected to continue. Agriculture, predominately dryland hay and wheat, and cattle and sheep has been and is expected to continue to dominate this completely rural economy. The area does lie adjacent to some extensive coal deposits, however, significant impact due to possible coal development is considered unlikely at this time.

Table 2. Little Missouri River Basin Population and Employment, Historical and Projected, 1930-1985*

	1930	1940	1950	1960	1970	1980	1985
Population	6903	5441	4705	4191	3421	2822	2500
Employment							
Total	2676	1838	1746	1578	1348	1159	1059
Agriculture	2065	1355	1128	913	728		
Mining	10	9	12	4	10		
Construction	50	63	47	54	31		
Manufacturing	51	8	23	26	38		
Services and Other	500	403	536	581	541		

*This table is based on U. S. Census data for Carter and Wibaux Counties. Projections by Montana Department of Natural Resources and Conservation, State Water Plan.

MONTANA WATER QUALITY STANDARDS

Montana has had a water pollution control law since 1907. However, the 1907 law was only applicable for the protection of domestic water supplies. In 1955, a water pollution control law was enacted which also gave protection to other beneficial uses such as fishing and wildlife, recreation, industrial and agricultural water uses. The 1955 law established a water pollution control council to establish rules and regulations and to guide the program administered by the State Board of Health (now State Department of Health). The seven-member Council had representatives from agriculture, municipalities, inorganic and organic industries and the State Department of Health, Fish and Game, and Water Resources. In 1971, the Water Pollution Control law was revised and the duties of the Council were transferred to the State Department of Health and the Council was made advisory. Five additional members were added to the Council.

One of the duties of the Water Pollution Control Council was to classify the streams of the State according to their most beneficial uses and to establish water quality criteria for the streams. Following a broad stream survey of the major streams in the State and public hearings, the classification work was substantially completed by 1960. With but a few minor exceptions, streams of the State were to be kept in suitable condition for water supply, fishing and recreation and agricultural and industrial water supply. This required treatment of many of the wastes not previously treated and additional treatment of some of the wastes previously treated. Montana then became one of the first states to have enforceable stream classifications.

Because some areas of the country were not making progress in water pollution control, Congress in 1965 passed the Federal Water Quality Act which

required that all states classify and establish water quality criteria for their interstate streams by July 1, 1967.

The Montana Water Pollution Control Council decided to revise the existing classifications and water criteria before submittal to the Federal government since ten year's experience had shown some areas where the existing standards could be improved. For example, it was felt that a higher dissolved oxygen content was desirable for a trout fishery. Following a public hearing in Helena during May 1967, revised classifications and water quality criteria were adopted for both interstate and intrastate waters and these were later approved by the Federal government. The revised standards require a higher degree of stream quality than the original standards. Also, new minimum treatment requirements were established which require at least the equivalent of secondary treatment for sewage and industrial wastes. The prior minimum requirement was primary treatment followed by adequate disinfection. Primary treatment removes solids by quiescent settling. Secondary treatment provides additional removal of organic solids by biological action. A sewage lagoon combines the primary and secondary processes into one. However, even before 1966, secondary treatment had been requested of most of our cities and industries in order to meet the stream standards.

In 1971, the State Water Pollution Control Act was revised which turned the functions of the Water Pollution Control Council over to the State Department of Health and Environmental Sciences. In 1972, the Federal Water Pollution Control Act Amendment of 1972 was enacted by Congress. This new act required Montana to revise its water quality standards. The State of Montana revised standards and these revised standards were adopted by the State Department of Health and Environmental Sciences on July 13, 1973. The new standards are expected to

become effective in November of 1973.

The Montana water quality standards serve as a functional tool in protecting water quality; however, there are a number of laws, statutes and regulations that complement the water quality standards and significantly assist in protecting water quality. Acts and statutes of the State of Montana administered by the Water Quality Bureau that directly influence water quality are:

Law or Statute	Title	Chapter	RCM
1. Water Pollution Control	69	48	1947
2. Public Water Supply	69	49	1947
3. Subdivisions	69	50	1947
4. Water and Wastewater Operators Certification	69	59	1947
5. Septic Tank Cleaners	69	54	1947

Similarly, the Bureau is responsible for enforcement of a number of regulations that directly influence water quality. The previously discussed water quality standards are of primary importance. The following regulations, however, also have an important influence on water quality in the state.

Reg. No.	Name
1. 51.100	Public Water Supplies and Plans for Sewer Systems
2. 51.300	Approval of Water and Sewer Facilities in Subdivisions
3. 52.101	Investigation of Ground Water Supply
4. 52.103	Surface Water Supplies
5. 51.300	Wastewater Discharge Permits for Sewage and Industrial Wastes
6. 51.350	Waste Discharge Permits for Confined Animal Feeding

WATER POLLUTION SOURCES

Water pollution in the Little Missouri River basin may be caused by a number of factors including municipal discharges, oil field wastes, runoff from bentonite mining operations, runoff from erodible soils, and agricultural waste waters. The characteristics of all known dischargers are summarized in Table 3.

Municipal Discharges

The communities of Ekalaka and Wibaux are the only two municipal dischargers in the basin. Ekalaka is in the Russell Creek drainage which is tributary to

TABLE 3

BASIN WASTE SOURCE INVENTORY

STATE Montana
BASIN Little Missouri
SEGMENT
TYPE WASTE SOURCES Municipal

	WASTE SOURCE IDENTIFICATION DATA									WASTE SOURCE QUANTITY AND QUALITY DATA														
NAME OF	TYPE OF	DISCHARGE LOCATION						DISCHARGE		AVERAGE	TYPE OF	PARAMETERS OF IMPORTANCE[5]												
		RECIVING										BOD5			TSS			pH	Fecal Coliform					
WASTE SOURCE	TREATMENT	WATER	TNS	RNG	SEC	TRACT	PERMIT NO.[2]			DAILY FLOW[3]	DISCHARGE[4]	mg/l	#/day	%Remvl	mg/l	#/day	%Remvl		number/100 ml.					
Ekalaka	Activated Sludge	Russell Cr. to Little Beaver Creek	02N	58E	30	DDA	23(S)			0.057	C	163	77	28					>10^4 all data from one survey					
Wibaux	Aerated Lagoon	Beaver Cr.	14N	59E	01	DRA	107(S)			Presently no discharge from new facility														

1 See explanation of description in Appendix
2 S - State issued; E - EPA issued; C - Corps of Eng. issued
3 For period of discharge, values in MGD
4 C - Continuous; I - Intermittent (Discharge Period Shown)
5 Those parameters listed on the discharge permit

Little Beaver Creek. The sewage treatment facilities for Ekalaka were constructed in 1948. The facility consists of gravity mains, one pump lift station and an activated sludge plant. The activated sludge plant consists of a bar screen, primary clarifier, combination areation tank and final clarifier, sludge digestor and chlorination unit. The population served by the plant is about 650 and the design population is 750. The final effluent is discharged to Russell Creek about five miles above its confluence with Little Beaver Creek (Plate I). Both Russell and Little Beaver Creeks are intermittent in this area, that is, they have flow only during spring runoff (April-May) or after a heavy rainfall. A 24-hour flow composite was collected July 30, 1973 on the treatment plant influent and effluent. Results of the analysis (Table 3) show a 28 percent BOD removal and an 83 lb/day effluent BOD load. Fecal coliform count for the effluent composite sample was greater than 10,000 colonies per 100 ml. of sample.

Effluent from Ekalaka's sewage treatment plant on July 30, 1973 entered Russell Creek and flowed downstream. The effluent seeps into the stream bottom along Russell Creek until, at a point about three miles below the plant, Russell Creek has no flow. Little Beaver Creek was also dry at its confluence with Russell Creek at this time. Russell Creek below the treatment plant is used mainly for livestock grazing. Effluent from Ekalaka's sewage treatment plant averages 57,000 GPD (gallons per day) and is the principal source of water in Russell Creek. The plant is not operating properly due to inadequate maintenance and poor operating techniques.

The community of Wibaux is in the Beaver Creek drainage. Prior to April 1973, the sewage treatment facility consisted of a large septic tank. Effluent from the tank was discharged to Beaver Creek. In the spring of 1973 a sewage lagoon was put into operation. The facility consists of a two pump lift station,

a two-cell lagoon with six aerators on the first cell and one on the second cell. The final effluent will be chlorinated. The cells are designed to be operated in series. The population of Wibaux is approximately 750 and the lagoon system was designed to accommodate a population of 700 persons. In October 1973 the second cell of the lagoon system was filling and there was no discharge from the system.

Discharge from the lagoon will be to Beaver Creek and it is expected that the discharge will meet secondary treatment requirements.

Industrial Discharges

There are no known industrial discharges in the Little Missouri River basin. There are, however, both operating oil fields and bentonite mines in the basin. The oil fields are located (Plate 1 and Figure 1) along the Cedar Creek Anticline which is an elongate geological structure in the northern part of the basin. The fields are Little Beaver, East Little Beaver and Fertile Prairie in the Beaver Creek drainage and the Repeat field in the Boxelder Creek drainage. In pumped oil wells, saline water is normally associated with the oil. The oil is skimmed from the water and the water is disposed of in some manner. In this basin all saline production water is reinjected into wells for disposal. Associated with the oil operation are small emergency storage pits which are used in case of equipment failures in the separator facility. There are an estimated 75 to 125 such pits in the basin. Nearly all the pits are located away from stream channels and all pits are fenced and have wires across the top to keep birds off water that may accumulate in the pits.

There are two bentonite mining operations in the Little Missouri River basin. Both mining operations are near Alzada and a total area of about 1500 acres is involved. Grinding and drying is done in adjacent states. The companies

involved are National Lead Industries and International Minerals and Chemicals Corporation. The Reclamation Division of the Montana State Land Department has been working with both of these companies to develop effective reclamation of the mining area. Many mining pits in the past have been left to fill up with water to be used for livestock watering. The average annual precipitation in this part of the basin is about 14 inches. This suggests a potential problem due to surface runoff from the erodible overburden. Drainage from both International Minerals and Chemicals Corporation and National Lead Industries would be north to Thompson Creek and then into the Little Missouri River or south directly into the Little Missouri River (Figure 1). Thompson Creek flows only during spring runoff and after heavy rains.

Stream sedimentation from these mining operations has not been examined in the detail. The area is remote, intense precipitation is infrequent and much natural land in the area is also erosive. The Montana State Department of Lands is working with the operators to minimize the environmental damage and reduce erosion.

Agricultural Waste Discharges

A variety of agricultural wastes are present in the Little Missouri River basin including irrigation return flows, animal wastes, runoff from range and cultivated lands and from land treated with pesticides and fertilizers. Although there are a number of potential agricultural pollutants, no water pollution problems have been identified during this investigation. Agricultural pollution is transient in both time and space and is complex due to the variability of agricultural practices.

The effect of agricultural wastes on water quality is generally difficult to determine without long-term exhaustive studies. There are no obvious agricultural

pollution problems in the basin. Future water quality monitoring and additional basin investigations will assist in quantification of agriculture's role in water quality.

Non-Point Pollution Sources

Some potential non-point pollution sources have been discussed under agricultural waste discharges. Sedimentation, animal wastes, fertilizers all can create non-point pollution sources. A variety of other non-point pollution sources can exist including erosion and sedimentation of non-agricultural lands, construction projects and toxic substances or salinity from geological formations in the area. There have been no non-point pollution sources identified in the basin.

SURFACE WATER RESOURCES

The Little Missouri River basin contains four major sub-basins. These are Beaver Creek, Little Beaver Creek, Boxelder Creek and the Little Missouri River above Little Beaver Creek. (Figure 1 and Plate 1). Six U. S. Geological Survey gaging stations are in or adjacent to the basin. These stations gage streamflow of the major stream in each sub-basin. Table 4 summarizes the sub-basin streamflow data. This data was obtained from the U. S. Geological Survey Water Resources Data (U. S. Geological Survey 1969, 1971, 1972). A schematic diagram of waters in the Little Missouri River basin is shown in Figure 4.

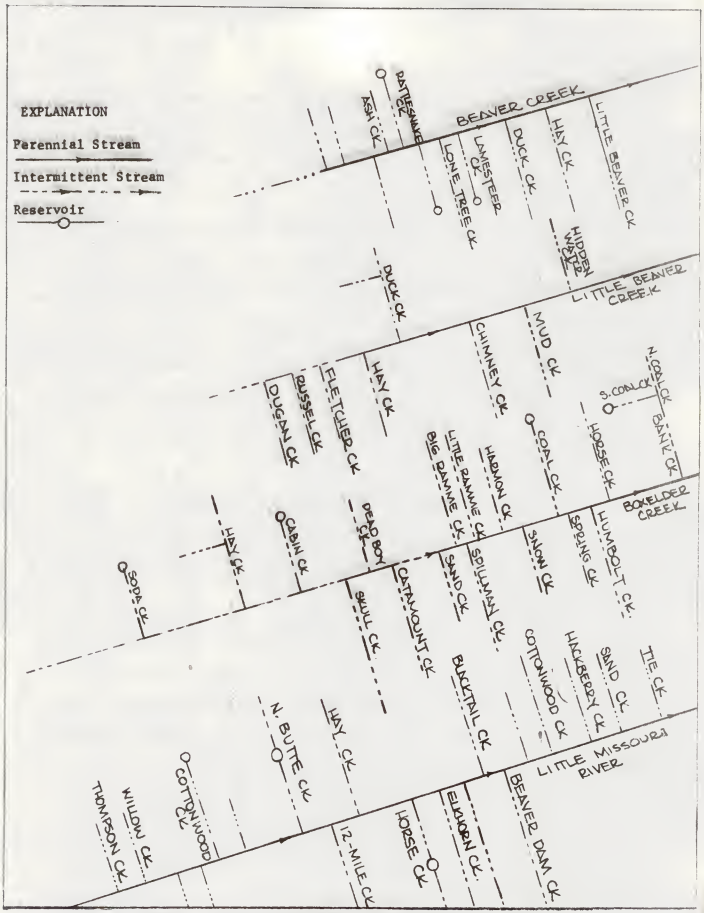


FIGURE 4 SCHEMATIC DIAGRAM OF WATERS IN THE LITTLE MISSOURI RIVER BASIN

TABLE 4. Summary of sub-basin and streamflow from gaged streams in the Little Missouri River Basin.

Station Name	Location	Drainage Area in (sq. mi.)	Years of Record	Minimum Stream Flow (cfs)	7 day-10 yr. Low Flow (cfs)	Average Annual Flow (cfs)
Beaver Creek at Wibaux, Montana	14N59E12AA	351	30	0	0	22.3
Little Beaver Ck. near Marmarth, N. Dak.	132N106W07A (N. Dak. 6.5 mi. downstream from MT state line	615 (574 in MT)	33	0	0	42.0
Box Elder Ck. near Webster, Montana	02N62E30A	1092	12	0	0	84.7
Little Missouri R. at Camp Crook, South Dakota	18N01E02C (S.D. 1 mi. downstream from MT state line	1970 (1187 in MT)	18	0	0	133
Little Missouri R. near Alzada, Montana	09S60E06AD	904 (121 in MT)	48	0	0	76.8
Little Missouri River near Marmarth, N. Dak.	132N106W7A	4570	33	0	0	260

Note: Presently only the stations on the Little Missouri River at Marmarth, North Dakota and Camp Crook, South Dakota will be continued.

Streamflow data from the Little Missouri River basin (Table 5 and 6) show a number of interesting features. There are great variations in daily, monthly and annual stream flow. A major period of flow is during spring runoff. The date of spring runoff is a function of weather and precipitation and is highly variable in both time and volume. March through early May is the most common snow-melt period; however, warm weather in mid-winter can produce significant streamflows. Summer rainstorms also can produce high or even yearly

TABLE 5. Typical Stream Flow Data for Beaver Creek, Little Beaver Creek and Boxelder Creek. (U.S. Geological Survey Water-Paper 1729)

3350. Little Beaver Creek near Marmarth, N. Dak.

Location.--Lat 46°16', long 103°58', in NE¼ sec.7, T.132 N., R.106 W., on left bank 150 ft upstream from concrete ford, three-quarters of a mile downstream from Corral Creek, 3 miles southwest of Marmarth, and 5 miles upstream from mouth.

Drainage area.--615 sq mi.

Records available.--April 1938 to September 1960.

Gage.--Water-stage recorder. Altitude of gage is 2,789 ft (by barometer). Prior to Mar. 15, 1941, wire-weight gage at site half a mile upstream at datum 0.57 ft higher. Mar. 15, 1941, to May 20, 1947, staff or wire-weight gages at present site and datum. May 21, 1947, to June 27, 1951, staff and wire-weight gages at site half a mile upstream at present datum.

Average discharge.--22 years (1938-60), 41.4 cfs (29,970 acre-ft per year); median of monthly means 0.5 cfs (23,900 acre-ft per year).

Extremes.--1938-60: Maximum discharge, 12,700 cfs Apr. 6, 1952 (gage height, 13.9 ft, from rating curve); from rating curve extended above 4,500 cfs on basis of slope-area measurement of peak flow. no flow at times in most years.

Monthly and yearly mean discharge, in cubic feet per second

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1951	4.26	2.43	1.82	0.99	1.82	48.8	10.5	6.55	14.2	38.0	9.28	95.3	19.5
1952	7.25	2.61	1.15	.33	.34	15.3	1272	15.1	5.49	1.77	6.80	0	118
1953	.36	1.62	1.06	1.01	2.74	26.0	14.8	45.1	163	5.84	45.0	7.22	17.1
1954	4.23	3.87	2.33	1.32	26.7	9.77	45.1	2.33	24.6	4.86	5.99	52.9	15.1
1955	.60	1.52	2.44	.02	.16	71.4	33.4	14.2	41.7	17.3	.17	0	12.4
1956	0	0	0	0	0	13.5	4.81	16.1	3.77	15.3	1.63	.00	4.64
1957	0	.72	.52	.29	3.9	15.1	79.6	2.81	56.7	6.22	10.7	13.5	15.7
1958	0	<2.21	.68	.32	.06	11.3	2.16	.00	53.0	43.6	.36	0	8.55
1959	0	.09	.56	.01	0	306	27.7	6.53	13.6	4.03	0	6.0	30.8
1960	.83	2.64	2.54	.02	.05	248	9.22	7.43	31.6	2.03	0	0	25.6

3366.3. Box Elder Creek near Webster, Mont.

Location.--Lat 45°54', long 104°33', in SE¼ sec.30, T.8 N., R.52 E., on left bank at Wayne Cox Ranch, half a mile west of South Dakota line, 5 miles (revised) upstream from Coal Bank Creek, 17 miles southeast of Webster, and 32 miles southeast of Baker.

Drainage area.--1,038 sq mi (revised).

Records available.--September 1958 to September 1960.

Gage.--Wire-weight gage. Altitude of gage is 2,950 ft (from topographic map). Prior to Feb. 19, 1960, staff gage at same site and datum.

Extremes.--1958-60: Maximum discharge observed during period, 3,190 cfs Mar. 25, 1960; maximum gage height observed, 12.38 ft Mar. 24, 1960 (backwater from ice); no flow Jan. 20, 22-27, 1960.

Remarks.--Diversions for irrigation of about 14,000 acres above station.

Monthly and yearly mean discharge, in cubic feet per second

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1959	-	-	-	-	-	-	-	-	-	-	-	-	-
1960	2.76	2.17	4.54	0.63	1.89	301	47.7	45.5	314	4.66	45.3	2.52	71.2

3365. Beaver Creek at Wibaux, Mont.

Location.--Lat 46°50', long 104°11', in NW¼ sec. 12, T.14 N., R.59 E., on upstream side of bridge on U. S. Highway 10 at Wibaux, 18 miles upstream from Little Beaver Creek.

Drainage area.--391 sq mi.

Records available.--April 1938 to September 1960.

Gage.--Wire-weight gage and crest-stage gage. Altitude of gage is 2,659 ft (by barometer). Prior to Sept. 21, 1940, staff or wire-weight gages at site about 500 ft upstream at different datums.

Average discharge.--22 years (1938-60), 25.3 cfs (18,330 acre-ft per year).

Extremes.--1938-69: Maximum discharge, 3,780 cfs Mar. 21, 1939 (gage height, 10.8 ft, site and datum then in use, from graph based on gage readings), from rating curve extended above 2,600 cfs; maximum gage height observed, 13.44 ft Mar. 24, 1943 (ice jam); no flow at times.

Flood of June 7, 1923, reached a discharge of about 30,000 cfs, from the average of three independent indirect measurements made at different sites. Flood in 1929 reported similar in magnitude. Flood in June 1921 reached a stage about 8.6 ft lower than 1929 (discharge, about 10,000 cfs, estimated on basis of cross-section and information by local residents).

Remarks.--Diversions for irrigation of about 150 acres above station.

Monthly and yearly mean discharge, in cubic feet per second

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1931	0.90	1.15	0.94	0.85	3.38	93.5	15.2	2.63	0.92	0.93	0.47	0.27	13.1
1932	.52	.85	1.09	0	.18	57.3	569	11.2	8.34	3.13	.23	.33	59.2
1937	.38	.75	.84	1.35	1.58	10.9	6.16	6.25	7.83	1.08	.03	.20	3.03
1954	.13	.52	1.04	.45	53.8	4.24	92.3	3.41	6.92	11.2	5.19	4.33	15.7
1955	2.87	1.51	1.13	.02	1.57	129	28.9	9.01	1.69	5.75	.72	0	14.9
1956	.15	.51	.15	0	0	8.99	4.50	1.40	.79	0	.53	.21	1.42
1957	.03	.32	.02	0	4.11	23.8	4.22	.39	9.77	3.04	.35	7.91	4.92
1958	.62	1.09	1.73	.64	.04	21.2	5.63	.63	4.23	39.7	.44	.22	6.71
1959	.15	.33	.54	.02	0	237	15.8	2.52	1.04	.12	0	0	27.9
1960	.08	.13	.23	.33	.03	214	4.5	1.74	2.44	.23	0	0	19.9

TABLE 6. Typical Stream Flow Data for Little Missouri River at Marmarth, North Dakota and Alzada, Montana. (U. S. Geological Survey Water-Supply Paper 1729)

3455. Little Missouri River at Marmarth, N. Dak.

Location.--Lat 46°19', long 103°51', in SW¼ sec.30, T.13 N., R.105 W., on left bank 30 ft downstream from bridge on U. S. Highway 12 in Marmarth and 1½ miles downstream from Little Beaver Creek.

Drainage area.--4,570 sq mi, approximately.

Records available.--March 1938 to September 1960.

Gage.--Water-stage recorder. Datum of gage is 2,856.32 ft above mean sea level, datum of 1929. Prior to June 20, 1950, various wire-weight gages on former highway bridge at present site at same datum. June 23, 1950, to Sept. 2, 1957, wire-weight gage at site 90 ft upstream at present datum.

Average discharge.--23 years (1938-60), 322 cfs (233,100 acre-ft per year); 222 cfs of yearly mean discharges, 270 cfs (195,000 acre-ft per year).

Extremes.--1938-60: Maximum discharge, 45,600 cfs Mar. 23, 1947 (gage height, 21.7 ft); maximum gage height, 23.4 ft Mar. 31, 1952 (backwater from ice); no flow for part of most years.

The greatest known flood occurred in June 1897 (stage unknown), from information by local residents. Other major floods occurred in March 1943, May 1939, and March 1920 and reached stages of about 21.5, 20.2, and 19.7 ft, respectively. (These stages are not comparable to stages during period of record, owing to construction of levees.)

Remarks.--Small diversions for irrigation above station. Records of chemical analyses for the period December 1949 to September 1951 and suspended sediment loads for the period August 1948 to September 1954 are published in reports of Geological Survey.

Monthly and yearly mean discharge, in cubic feet per second

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1951	26.6	15.7	4.2	3.7	3.9	234	101	52.9	152	231	114	303	* 109
1952	72.6	17.0	107	.9	311	634	2,891	160	69.6	81.6	35.3	6.98	473
1953	7.35	18.6	2.9	1.4	4.7	412	82.2	544	1,609	96.3	343	34.1	264
1954	30.7	19.6	13.3	4.95	82.5	59.9	428	21.5	93.4	47.5	175	95.2	83.4
1955	7.79	8.13	1.60	.25	0	249	810	533	176	69.6	20.2	0	156
1956	1.31	.37	0	0	0	445	78.3	84.3	76.5	344	213	15.1	134
1957	3.00	19.3	4.7	.26	1.85	145	150	30.7	443	94.6	69.6	259	101
1958	23.0	39.0	15.3	2.06	3.84	82.7	75.2	134	637	266	8.07	1.65	132
1959	.87	6.03	2.4	.1	0	1,618	278	37.1	47.4	92.2	.84	23.8	178
1960	14.4	13.6	3.0	.34	.15	701	133	83.3	743	41.3	113	7.64	238

3340. Little Missouri River near Alzada, Mont.

Location.--Lat 45°05', long 104°24', in NE¼SW¼ sec.6, T.9 S., R.60 E., on right bank 1½ miles downstream from Thompson Creek and 4 miles north of Alzada.

Drainage area.--604 sq mi (revised).

Records available.--June 1911 to December 1914 (no winter records in most years), March 1915 to September 1929, August 1936 to September 1938, March 1939 to September 1960. Records collected at station of same name in 1904 at site 8 miles upstream are not equivalent (published as "at Alzada" in WSP 1309). Monthly discharge only for some periods, published in WSP 1309.

Gage.--Water-stage recorder. Datum of gage is 3,367 ft above mean sea level (river-profile survey). Prior to Apr. 4, 1918, staff gage at site 150 ft upstream at datum about 2.0 ft higher. Apr. 4, 1918, to June 13, 1947, chain or staff gage at site 300 ft upstream at datum 2.07 ft higher.

Average discharge.--40 years (1912-13, 1915-25, 1928-32, 1935-60), 81.8 cfs (59,260 acre-ft per year).

Extremes.--1911-25, 1928-32, 1935-60: Maximum daily discharge, 6,000 cfs Apr. 4, 1944; no flow at times.

Remarks.--Several diversions of floodwaters for irrigation of hay meadows above station. Some storage in coulees. Records of chemical analyses for the periods May to September 1949, December 1949 to July 1950, and October 1950 to July 1951, suspended sediment loads for the period March 1949 to December 1951, and water temperatures for the period June 1949 to December 1951, are published in reports of Geological Survey. (Records published as Little Missouri River at Alzada, Mont.)

Monthly and yearly mean discharge, in cubic feet per second

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1951	3.44	0.25	0.47	0.26	0.23	0.44	0.33	3.32	58.8	14.6	18.9	18.6	9.37
1952	.57	.21	.01	.06	.78	138	122	7.66	5.61	11.4	.60	.01	23.0
1953	.14	.003	.01	.32	.42	57.1	1.60	145	244	18.7	57.8	.12	44.0
1954	.02	.74	.45	.24	.02	.25	63.4	1.59	3.07	.02	74.6	.02	7.72
1955	.07	.13	.07	.07	.13	8.14	423	909	45.0	29.1	7.01	.05	60.0
1956	.00	.09	6.36	5.45	1.12	250	9.60	22.1	58.9	5.30	.19	0	21.6
1957	0	0	0	0	.02	12.7	14.5	20.7	102	1.33	63.4	17.1	12.7
1958	4.48	1.65	.14	.19	.69	4.62	64.5	47.3	156	6.72	.02	0	32.3
1959	0	0	.00	.03	.13	164	12.0	.73	2.32	24.6	.07	.07	17.5
1960	.08	.01	.52	0	.08	104	9.64	.21	102	.06	76.9	.0002	4.15

peak runoffs. The sparse vegetation in the basin and soils with low infiltration rates provide conditions favorable for rapid runoff and rapid changes in flow. Records of the U. S. Geological Survey show that flows can vary by three orders of magnitude in two days due to intense precipitation and rapid runoff. The year to year total runoff can vary by factors of 10 to 20 or more. Geological formations in much of the basin do not transmit and store significant quantities of groundwater; consequently, most streams do not have a sustaining groundwater base flow.

The Beaver Creek drainage (Plate I) contains approximately 445 square miles. Beaver Creek is the only perennial stream in the drainage. All other streams are intermittent. Beaver Creek originates in the southeastern part of Fallon County and generally flows northward into Wibaux County, then joins the Little Missouri River in North Dakota. Beaver Creek is intermittent in its headwaters, but becomes perennial about ten miles downstream. In 28 years of record the maximum discharge was about 30,000 cfs (cubic feet per second) and a minimum discharge of zero has frequently been recorded. August through February period is the usual low flow period.

Little Beaver Creek drains about 574 square miles in the north-central part of the basin. It originates in Carter County and flows generally northward into Fallon County and then into North Dakota where it joins the Little Missouri River. Little Beaver Creek is intermittent in much of its headwater area (approximately the first 12-14 miles), then becomes perennial. Based on 27 years of record at the U. S. Geological Survey station at Marmarth, North Dakota, the maximum recorded discharge was 12,600 cfs and the minimum flow is zero at times in most years. The low flow period is August through February.

Box Elder Creek drains an area of about 1155 square miles and originates in the southwest portion of Carter County. It generally flows northeastward across Carter County, then enters North Dakota where it joins the Little Missouri River. Box Elder Creek is intermittent for about the first 15 to 20 miles, then becomes perennial. Based on 11 years of record at the U. S. Geological Survey station at Webster, Montana, the maximum recorded discharge was 7340 cfs and the minimum was no flow at numerous times.

The Little Missouri River drains about 1187 square miles in Montana. The river arises in northeastern Wyoming, then flows through the southeastern part of Carter County and crosses the state into South Dakota. The river then turns northward and flows along the western portion of North Dakota, then into the reservoir formed by Garrison Dam. Based on 46 years of record at the U. S. Geological Survey station near Alzada, Montana, the maximum recorded discharge was 6000 cfs and the minimum was zero at times. The Little Missouri almost always flows water in Montana and is considered a perennial stream.

In addition to streams there are a number of small reservoirs that are used to catch runoff water for cattle watering and some irrigation.

WATER QUALITY

There is little available data on water quality in the Little Missouri River basin. The U. S. Geological Survey has collected sediment and chemical quality data on the Little Missouri River at Alzada, Montana and the Little Missouri River at Marmarth, North Dakota. They also obtained chemical data from the Little Missouri River at Camp Crook South Dakota and from Boxelder Creek near Webster, Montana.

The Water Quality Bureau sampled five water quality stations in the basin. A summary of data available is in Table 7.

TABLE 7. Summary of Water Quality Sampling Stations and Data From the Little Missouri River Basin.

Sampling Station Designation	Sampling Station Location	Sampling Agency	Data Type Chem.	Data Type Sedm.	Dates of Collection
Little Missouri River at Alzada, Montana	09S59E24DBB	Water Quality Bureau	X		July-Sept. 1973
Little Missouri River at Alzada, Montana	09S59E24DB	U.S. Geological Survey	X		May 1949-Sept. 1951
Little Missouri River at Alzada, Montana	09S59E24DB	U.S. Geological Survey		X	March 1949-Sept.1951
Little Missouri River at Camp Crook, S.D.	18N01E02C	U.S. Geological Survey	X		Oct. 1972-Sept. 1973
Boxelder Creek, Mill Iron, Montana	01N61E17CDD	Water Quality Bureau	X		July-Sept. 1973
Boxelder Creek, Webster, Montana	02N62E29B	U.S. Geological Survey	X		July 1972-June 1973
Little Beaver Creek Ekalaka, Montana	03N58E34DAA	Water Quality Bureau	X		July-Sept. 1973
Beaver Creek Wibaux, Montana	14N59E01DBB	Water Quality Bureau	X		July-Sept. 1973
Little Missouri River at Marmarth, N.D.	133N105W30C	U.S. Geological Survey		X	Oct. 1948-Aug. 1952
Little Missouri River at Marmarth, N.D.	133N105W30C	U. S. Geological Survey	X		Dec. 1949-Sept. 1951
Little Missouri River at Capitol, Montana	05S62E03ABC	Water Quality Bureau	X		July-September 1973

NOTE: X in column indicates these data are being collected.

The U. S. Geological Survey, during periods when the stations were active, has collected sediment samples on a daily basis together with temperature. Chemical constituents are generally analyzed one to several times monthly by the U. S. Geological Survey. The Water Quality Bureau collected samples in

July and September of 1973. Typical results of water quality sampling in the basin are shown in Tables 8, 9 and 10.

Generally, water quality in the Little Missouri River Basin is poor to fair. The water is a sodium-sulfate type; hard to extremely hard with moderate to high turbidities. The waters contain moderate to high amounts of dissolved solids, but are basic (pH above 7.0) and contain very small amounts of heavy metals. The concentration of fecal coliform organisms is moderate to high.

Some quality parameters in streams in the drainage exceed the U. S. Public Health Service Drinking Water Standards; however, Montana Water Quality Standards generally refer to additions to natural water concentrations and not the absolute quality. With the exception of coliform organisms, waters in the basin meet the state standards for $B\text{-}D_3$ classification and the basin is classified as effluent limited. Very limited fecal coliform data (Table 8) shows some concentrations that exceed state standards. There are, however, insufficient data to warrant changing the basin classification. Additional analysis will be required to determine the range in fecal coliform concentration.

The concentration of sediment and dissolved minerals varies widely with streamflow. The concentration of dissolved minerals decreases as streamflow increases. This is due to dilution by runoff from precipitation or from snowmelt. As is typical of all streams, the decrease in concentration of dissolved constituents is less than the increase in streamflow. For example, if streamflow increased by a factor of 10, the concentration of dissolved constituents might decrease only by a factor of 2. One important factor that emerges from this relationship is that total loads of dissolved constituents are higher during high flows even though the concentration of dissolved minerals is lower.

Suspended sedimemt concentration increases rapidly with increases in streamflow. The periods of highest sediment concentration are periods of

TABLE 8 . TYPICAL RESULTS OF CHEMICAL ANALYSES OF WATERS FROM THE LITTLE MISSOURI RIVER BASIN
(All Constituents Reported in Milligrams Per Liter Except as Indicated)

NOTE-BOOK	SAMPLING STATION DESIGNATION	SAMPLING STATION LOCATION	DATES SAMPLED	FLOW (cfs)	TEMPERATURE (°C)	pH (S.U.)	DISSOLVED CALCIUM (Ca)	DISSOLVED MAGNESIUM (Mg)	DISSOLVED SODIUM (Na)	DISSOLVED POTASSIUM (K)	CHLORIDE (Cl)	SULFATE (SO4)	FLUORIDE (F)	NITRATE (NO3)	NITRITE (NO2)
1	Little Missouri River at Alzada, Montana	0955922N0E8	07-03-73		24.3	7.90	45	22	178		120	0	365	8.5	0.24
			09-14-73	0	21.5	7.85									
2	Little Missouri River at Capitol, Montana	0956420N3ABC	07-03-73		22.5		45	36	132		145	0	445	5.0	0.25
			09-19-73	0	8.0	8.00									
3	Beaver Creek near Mill Iron, Montana	0954E17CDD	07-03-73	22	24.5	8.00	45	22	108		188	0	260	5.1	0.16
			09-14-73	0	21.0										
4	Little Beaver Creek near Ekalaka, Montana	0953E23CAA	07-30-73	1.2	24.5	8.10	42	42	222		564	0	321	3.0	
			09-19-73		20.0										0.27
5	Beaver Creek at Nihart, Montana	1453900125	06-06-73	59											
6	Little Missouri River at Alzada*	0955N2A0E	12-05-68	0.2		7.8	103	37	211*		286		525	7.0	2.4
			03-05-50	478		7.0	48	24	98		80		360	2.0	2.7

NOTE-BOOK	PHOSPHATE (PO_4)	CALCULATED DISSOLVED SOLIDS	TOTAL DISSOLVED SOLIDS	TOTAL HARDNESS ($CaCO_3$)	TOTAL ALKALINITY ($CaCO_3$)	SPECIFIC SPECTRAL CONDUCTANCE (micromhos at 25°C)	ABSORPTION RATIO	LABORATORY TURBIDITY (JTU)	5-DAY BIOLOGICAL OXYGEN DEMAND (BOD_5)	FECAL COLIFORM (Counts per 100 ml)	TOTAL IRON (Fe)	TOTAL ZINC (Zn)	TOTAL COPPER (Cu)	TOTAL CADMIUM (Cd)	ADDITIONAL PARAMETERS AND REMARKS
1	0.08	1239		535	98	1664	3.4	180	2.9	500	0.36		<0.01	<0.01	
						2510		10		21					
2		630		310	119	1162	3.3	59	2.8	130	0.36		<0.01	<0.01	
						2150		15	2.4	13					
3	0.04	629		230	155	824	3.3	86	3.5	900	0.38		0.01	<0.01	
						1125			2.8	24					
4	0.01	1164		326	482	1492	3.3	18	4.2	100	0.33		0.01	<0.01	
						1390		8	3.6	32					
5									3.7	280					
6		1100		408		1500					0.02				
		638		238		840					0.04				

*These Data Taken From U. S. Geological Survey Water-Supply Paper 1187

*This Data is Reported as Na and K

TABLE 9. Typical Temperataure Data for the Little Missouri River basin. (Fish and Game Commission, 1969).

204. Beaver Creek at Wibaux, Mont. (6-3365)

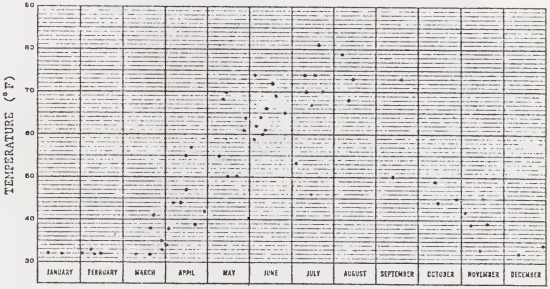
Location.--At gaging station, lat 46°59', long 104°11', in NE¼NE¼ sec.12, T.14 N., R.59 E., on upstream side of bridge on U. S. Highway 10 at Wibaux, 12 miles upstream from Little Beaver Creek, and at mile 62.5. Altitude of gage is 2,650 ft (by barometer).

Drainage area.--351 sq mi.

Water temperature records available.--60 spot observations made at time of discharge measurements during period April 1949 to December 1965.

Extremes.--Discharge 1938-65: Maximum, 3,780 cfs Mar. 21, 1939; no flow at times.

Water temperatures 1949-65: Maximum observed, 81°F July 16, 1952; minimum, freezing point on many days during winter months.



Spot observations of water temperatures, 1949-65

Water temperatures at time of discharge measurements

Date	Time	°F	Date	Time	°F	Date	Time	°F	Date	Time	°F	Date	Time	°F	Date	Time	°F
January			February			March			April			May			June		
5-61	1215	32	1-54	1505	32	9-54	1500	32	5-49	1635	44	5-49	1100	55	4-49	1120	62
14-64	1420	32	9-54	1455	32	23-54	1245	41	20-50	1100	39	10-50	1030	50	15-50	1640	72
			7-63	1300	32	21-61	0750	38	2-52	1630	38	28-52	1500	61	24-52	0830	65
			5-64	1110	33	21-62	1630	32	29-53	1825	42	9-61	1525	70	16-53	0900	69
						28-62	1730	35	14-54	1350	55	15-62	1500	50	3-54	1700	59
						30-64	1635	33	17-62	1500	57	29-62	1100	64	7-62	0730	64
									9-63	1350	44	7-63	1500	68	4-63	1705	74
									14-64	1400	47				8-63	1935	60
									1-65	1500	34				9-63	0930	61
															13-63	1100	66
July			August			September			October			November			December		
10-49	1725	70	11-52	1700	73	14-50	1030	50	12-49	1010	44	15-50	1200	33	30-53	1525	34
13-50	1000	67	9-55	0700	68	16-52	1730	73	11-50	0900	69	18-52	1330	39	9-63	1645	32
16-52	1645	81	4-65	1500	79				29-57	1420	45	17-55	1425	45			
2-54	1250	53										5-54	0925	39			
10-62	1445	74										2-65	1040	42			
20-62	1930	70															

TABLE 10. Typical Suspended Sediment Data for Little Missouri River basin. (U. S. Geological Survey Water-Supply Paper 1198).

LITTLE MISSOURI RIVER AT ALZADA, MONT.--Continued

Suspended sediment, water year October 1950 to September 1951.--Continued

Day	April			May			June		
	Mean discharge (cfs)	Suspended sediment: Mean concentration (ppm)	Suspended sediment: Tons per day	Mean discharge (cfs)	Suspended sediment: Mean concentration (ppm)	Suspended sediment: Tons per day	Mean discharge (cfs)	Suspended sediment: Mean concentration (ppm)	Suspended sediment: Tons per day
1------	0.8			0	--	0	1.4	50	0.7
2------	.8			.1	33	(t)	9.3		
3------	.7			.1			29	--	e18
4------	.7	28	(t)	0	--	0	60	110	sb22
5------	.8			0	--	0	12	66	2.1
6------	.6			0	--	0	3.8	91	.9
7------	.5			0	--	0	1.2	83	.3
8------	.5			0	--	0	.9	83	b.2
9------	.4			0	--	0	1.6	53	.3
10------	.4	41	(t)	.1			1.9	71	.2
11------	.3			.1	85	.6	1.0	89	.2
12------	.5			7.8			.5	85	.1
13------	.9	32	0.1	5.3			.2	112	.1
14------	2.0			4.4			6.1	211	s4.7
15------	.3			15	45	1.4	79	264	s62
16------	.1	58	(t)	15			50	100	s15
17------	.1			9.8			223	3,340	s3,520
18------	0	--	0	7.8	31	.7	271	4,430	s3,540
19------	0	--	0	6.2			287	3,280	s2,850
20------	0	--	0	6.9			221	8,550	s5,130
21------	0	--	0	5.9	38	.8	215	5,050	s3,300
22------	.1			5.3			129	1,120	390
23------	.2			3.8			78	850	179
24------	.2			2.7			43	710	82
25------	.2	38	(t)	1.3	38	.1	17	500	23
26------	.2			.8			8.3	480	12
27------	.1			.4			5.8	360	6.0
28------	.2			.3			3.8	370	3.8
29------	.1			.3	80	.1	2.8	280	2.1
30------	0	--	0	.3			2.5	240	a1.6
31------	--	--	--	.4			--	--	--
Total-	11.5	--	1.0	102.7	--	11.9	1,761.0	--	18,537.0

Day	July			August			September		
1------	4.2	--	e3.4	0.3			60	3,120	s422
2------	6.3	--	e4.4	.3			54	1,510	s207
3------	16	--	e24	.3			74	2,040	s438
4------	43	--	e130	.2	47	(t)	49	1,800	s221
5------	20	--	e32	.2			54	4,070	593
6------	5.8	--	e3.8	.1			100	3,910	s1,070
7------	1.2	--	e.8	.1			94	2,720	s706
8------	.3			0	--	0	27	1,250	s97
9------	.2	--	e.1	0	--	0	13	635	22
10------	.2			0	--	0	5.1	510	7.0
11------	5.7	260	sb13	0	--	0	4.2	445	5.0
12------	97	1,500	sb600	0	--	0	4.2	319	4.5
13------	171	1,900	s905	0	--	0	3.2	398	3.4
14------	54	705	s123	0	--	0	3.0	304	2.5
15------	16	110	s5.5	.1	47	(t)	2.8	255	1.9
16------	5.8	130	2.0	37	1,230	s615	3.2	254	2.2
17------	2.1	78	s.5	210	7,740	4,310	1.8	210	1.0
18------	.5	73	.1	77	5,820	s1,300	1.1	169	.6
19------	.1	87	(t)	19	2,560	s140	.9	210	.5
20------	0	--	0	8.8	1,160	30	.3		
21------	0	--	0	8.9	750	14	.3		
22------	.3	78	s.2	8.5	550	13	.3	142	.1
23------	.2			10	410	11	.2		
24------	.2			17	200	14	.3		
25------	.3	64	(t)	20	200	11	.3		
26------	.3			19	210	11	.3		
27------	.3			17	190	8.7	.3		
28------	.4			21	150	8.5	.3	75	.1
29------	.4	52	(t)	21	80	4.5	.4		
30------	.4			23	100	9.5	.3		
31------	.3			59	2,560	s393	--	--	--
Total-	432.8	--	1,858.2	568.6	--	7,223.4	537.6	--	3,852.9

Total discharge for year (cfs-days)..... 3,628.7

Total load for year (tons)..... 31,609.2

e Estimated

a Computed by subdividing day.

t Less than 0.05 ton.

s Computed from estimated concentration graph.

b Computed from partly estimated concentration graph.

high streamflow. The sediment load therefore is greatly increased as streamflow increases. Based on available data, this general condition appears to be true in the Little Missouri River Basin.

Temperatures of water in streams in the basin (Figure 9) are characterized by freezing on many days in December, January, February, and early March; then a gradual warming until, in July and early August, maximum temperatures are reached. Maximums are often 75 to 80° F with occasional peaks above 80° F. In late August, a cooling trend ensues and the streams cool relatively rapidly until in late November and early December freezing temperatures are again common.

Suspended sediment and dissolved mineral data are inadequate to make any meaningful comparisons between sub-basins. Coliform, BOD and nutrient data are very scarce and biological data are totally lacking.

MANAGEMENT STRATEGY AND PLAN

A water quality management strategy should be designed to maintain or enhance water quality in the basin. The strategy also must consider requirements of all federal and state laws and regulations. The Federal Water Pollution Control Act Amendments of 1972 provide that all dischargers other than publicly owned treatment works, not later than July 1, 1977, effluent limitations are to be achieved which represent the application of the best practicable control technology currently available. All publicly owned treatment works must achieve secondary treatment by July 1, 1977.

For a sparsely populated area with few pollution sources such as the Little Missouri River basin, a water quality management strategy can be relatively uncomplicated. From a basin strategy, management programs or plans can be developed and implemented. After plan development and implementation, waters and wastes in the basin must be checked to determine the actual influence of the plan on basin waters. Water quality management by its very nature is an iterative process, that is, a plan must be followed, the results checked and

the program modified and the results again checked. In the Little Missouri River basin, the basic strategy consists of monitoring of waste discharges and control of land use activities to abate potential pollution problems.

The treatment plant at Ekalaka is not producing an effluent that meets Montana's water quality standards. The Water Quality Bureau plans to monitor the plant operation to determine plant operating or facility deficiencies. The plant will then be placed on a compliance plan. When the Wibaux sewage lagoons begin discharging the effluent will be sampled and analyzed to determine if the system is meeting water quality standards. It is expected that this system will meet secondary treatment standards and have an acceptable effluent. Federal and state standards for sewage effluents require 85 percent removal of BOD_5 (5-day Biochemical Oxygen Demand) and BOD_5 and Total Suspended Solids cannot exceed an average of 30 mg/l (milligrams/liter) per month or 45 mg/l per week. Also fecal coliforms cannot exceed a geometric mean of 200 organisms per 100 milliliter month or 400 organisms per 100 milliliter per week.

The future of bentonite mining in the basin is unknown. No great change in the rate of mining is expected. The Montana State Department of Lands is working with the mining companies to develop land reclamation plans that will minimize the environmental effects of the mining. Site visitations and grab sampling of runoff from mining areas is anticipated in the future.

Uranium and coal deposits exist in the basin and mining will probably occur in the future. No mining is expected in the next few years; however, both uranium and coal are both of significant interest, and mining is to be expected. Montana's land reclamation and water quality laws, statutes and regulations should provide an administrative and legal basis for prevention of water degradation.

Although there is no active oil exploration or development in the basin, such activities will probably occur in the future. The Montana Oil and Gas

Commission and the U. S. Bureau of Reclamation are responsible for activities associated with oil production including construction of emergency ponds. The Water Quality Bureau plans to continue close cooperation with these agencies to insure that oil production includes construction of emergency ponds and does not create any water quality problems.

There are no known water quality problems associated with agricultural activities in the basin; however, agriculture certainly can create long-term water quality changes and problems. The strategy for abatement or elimination of such problems is to work with federal, state and local organizations on land use plans. Specific agricultural problems that occur in the basin will be examined in the field and corrective actions taken.

SURVEILLANCE PLAN

Upon completion of the water quality management plan for the Little Missouri River basin, long-range water quality surveillance network will be established. There are two operating water gaging stations in the basin. The stations are at the Little Missouri at Marmarth, North Dakota which is near the Montana state line, and the Little Missouri at Camp Crook, South Dakota. The U. S. Geological Survey water quality station at Boxelder Creek and at Camp Crook, South Dakota will be discontinued in the fall of 1973. A U. S. Geological Survey water quality station will be established on the Little Missouri River at Marmarth, North Dakota to monitor chemical and sediment concentrations. Water quality sampling by the Water Quality Bureau will be very limited in the basin beginning in 1974. There are no other active quality stations in the basin.

A surveillance network is useful for a variety of reasons including:

1. Insuring that existing discharges are in compliance with discharge permit conditions.

2. Checking to see if instream water quality meets Montana's water quality standards.

3. Providing data on long-term water quality changes in the basin.

Although no severe water quality problems have been identified in the basin, there are some activities that could cause both short-term and long-term water quality changes in basin waters.

Collection, sampling and analysis represents a major investment of time and funds. A surveillance program should obtain theneeded information at the least possible cost. The quality of water in the basin is highly variable and depends on a number of factors including flow rate, season, and antecedent conditions. Continuous monitoring of quality is extremely expensive and periodic monthly or weekly sampling can easily miss major quality changes. For the Little Missouri River basin, a periodic sampling program to assess general water quality in the basin is probably appropriate. The Water Quality Bureau will establish two stations - one on Little Beaver Creek near the Montana state line and one on Boxelder Creek near Webster, Montana. Both these stations have inactive gaging stations nearby and stream stage and flow can probably be obtained. The stations will be sampled twice in 1974 and the samples analyzed for standard chemical constituents, fecal coliform and suspended solids. The second year and succeeding years these stations will be sampled twice and the samples analyzed for selected chemical constituents, fecal coliform, and suspended solids. The streams will be sampled during the spring runoff and during the fall low flow.

In addition to stream surveillance, municipal wastes also will be monitored. The community of Wibaux will sample and analyze effluent from the lagoon system on a quarterly basis. Parameters to be measured are flow, BOD_5, total suspended solids, settleable solids, pH, and specific conductance. The frequency and

parameters are in accordance with the NPDES (National Pollution Discharge Elimination System) and results will be submitted to the state Water Quality Bureau and the EPA.

The community of Ekalaka will be required to sample BOD_5, total suspended solids, and fecal coliforms twice monthly. Residual chlorine and pH are to be sampled daily and flow measured with a continuous recorder. The data again will be submitted to the Water Quality Bureau and the EPA.

The state Water Quality Bureau will also collect and analyze samples from these communities at least once a year.

MUNICIPAL FACILITIES INVESTMENTS

It is expected that there will be no major investments for municipal wastewater facilities in the Little Missouri River basin. A minor investment probably will be needed for maintenance and repair of the Ekalaka secondary treatment plant. With proper repair, operation and maintenance, it is expected that the effluent from the Ekalaka plant will meet Montana's water quality standards.

PUBLIC HEARING

On October 25 at 7:30 P.M. a public hearing was held in the courtroom of the Carter County Courthouse, Ekalaka, Montana. A taped record of the hearing was made by the Water Quality Bureau. There were no written comments on the Little Missouri River Water Quality Management Plan submitted at the hearing and there were no formal oral comments given when requested by the hearing officer. Participants in the hearing informally discussed the plan and representatives from the U. S. Soil Conservation Service offered to review the section on soils. A few minor corrections in the plan text were mentioned at the hearing and incorporated into the final plan text. At the conclusion of the hearing an additional 30 days were allowed for submission of comments on the plan. No additional comments

were received.

The hearing notice was posted 30 days prior to the hearing and notices were published as required by state regulations. Letters were sent to all persons, organizations and groups that were thought to have an interest in this matter.

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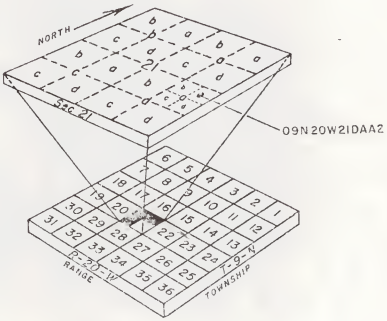
APPENDIX 2

SYSTEM FOR GEOGRAPHIC LOCATION OF FEATURES

Wells, springs, water-sampling locations, and stream-gaging locations are assigned numbers based on the system of land subdivision used by the U. S. Bureau of Land Management. The number consists of twelve characters and describes the location by township, range, section, and position within the section. The figure below illustrates the numbering method. The first three characters of the number give the township, the next three characters the range. The next two numbers give the section number within the township, and the next three letters describe the location within the quarter section (160-acre tract) and the quarter-quarter section (40-acre tract), and the quarter-quarter-quarter section (10-acre tract). These subdivisions of the 640-acre section are designated a, b, c, and d in a counterclockwise direction, beginning in the northeast quadrant. If there is more than one feature in a 10-acre tract, consecutive digits beginning with 2 are added to the number. For example, if a water-quality sample was collected in sec.21,T.9N.,R20W, it would be numbered 09N20W21DAA2. The letters DAA indicate that the well is in the NE¼ of the NE¼ of the SE¼, and the number 2 following the letters DAA indicates there is more than one water-quality sampling location in this 10-acre tract.